run in a conduit between the tracks, and the cars make connection with it by a grip passing through a slot in the conduit. There are several objections to this system. One of the most serious is the initial cost, the conduit alone costing from $50,000 to $80,000 per mile of single track. The conduit must be made large, it is difficult to clean, the pressure is liable to distort it and close the slot; its depth — varying from two to three feet — is liable to interfere with steam, gas, or water pipe. A break in the cable will suspend the entire traffic on the line. A broken strand is apt to foul the grip and pile one car on another, as has happened in Philadelphia. The efficiency of the system is not over twenty to twenty-five per cent, while to guard against accident the engine outfit is usually from two to four times that required at any time. Any extension of a cable line is expensive because the length of the cable is fixed. The speed of the cars is limited to that of the cable, so there is no chance for them to catch up if they get behind time; the motion, too, is uneven and unpleasant.

For electric traction Mr. Sprague claims the following advantages. It will do the work more satisfactorily and at a less cost than horses; on levels and up and down grades electric-motor cars can be run much faster than horse-cars; they can be gotten under way and stopped much more quickly; the equipment will occupy thirty-five per cent less space than horse-cars, the horse space being saved, and this fact, together with the ability to back when necessary and to quickly gain headway, enables an electric car in a narrow and crowded street to work a passage through where horse-cars would be stopped. Electric cars can be run more safely on down grades, since if the brake-chain breaks the car can be controlled by the motors, reversing when necessary. The motion of an electric car is smooth, and its starting and stopping are easy; the cars are clean, they can be lighted and heated by electricity; the streets are cleaner, and objectionable stables are not needed. It becomes feasible to operate branch lines, and also combinations of grades, curves, and ill-conditioned streets, that would be prohibitory to any other system.

To the objections that have been urged against electric systems, — that an extended system cannot be operated by electricity, that the lines may break down, that a large number of cars cannot be operated simultaneously, especially when bunched up, and that armatures and brushes burn up, — Mr. Sprague opposes his own very extensive experience, especially in the case of the Union Passenger Railroad in Richmond, where all of these difficulties have been met and overcome.

Before giving the details of the Richmond road, Mr. Sprague explained from curves some important points in the theory of electric motors for traction work. Discussing the different methods of gearing the armature of the motor to the axles of the car wheels in order to reduce the velocity, he concludes that there is only one good way, which is to centre the motor on the axle, suspending it flexibly from the car body or truck, and driving the axle by gearing with one or two reductions according to the nature of the service.

Taking up the methods of supplying the current to the motors, from storage-batteries on the cars, from overhead wires, or from wires in a conduit underground, Mr. Sprague first discusses storage batteries. These he considers as extremely promising for surface traction, but at the present state of development the excessive weight, the depreciation and cost, lack of capacity, and the space taken up in the car, make their success problematic. The weight of the car is so great — almost 20,000 pounds for a loaded car — that many of the tracks now in use would have to be rebuilt for them.

The difference in cost between an overhead and conduit system is mainly in the cost of the conduit, $25,000 to $30,000 a mile. The latter has the advantage that there are no overhead obstructions, and it can therefore be used in streets where the former is not permitted. Its disadvantages are cost, possibilities of leakage, and difficulty in cleaning and repair.

The overhead system is cheap, easily insulated and repaired; if properly constructed it need not be unornamental nor dangerous, — in fact the electrical pressure should not be great enough to endanger life. Mr. Sprague recommends this system for suburban districts, for comparatively narrow streets, for all streets operating under an elevated railroad structure, or where the tracks are near a sidewalk.

To illustrate the advantages of electricity for certain classes of traction work, Mr. Sprague proceeded to describe the equipment and operation of the Richmond street railroad, a description of which has appeared in this journal. The road is a difficult one, practically impossible for horse traction. There are grades of over ten feet in a hundred, and curves of small radius on heavy grades. The total trackage is twelve miles, the equipment is forty cars. Each car axle is geared to a motor of 7½-horse power, capable of working up to 15-horse power if required. The motors are out of sight, and are practically noiseless. The system used is the overhead. The power station is in the middle of the line, and is provided with boilers and engines of 375-horse power. In distributing the current a main conductor is taken along the line of track, either on the poles or underground, and is connected at intervals to the overhead working conductor, from which the current is taken. This allows a small overhead wire, and a break in it will not interrupt the traffic on the line. The return circuit is through the car-wheels to the rails and the earth. This road has been running long enough to allow reliable figures as to the expense being obtained. It is found that the cost of power is $1.48 per car day, the car making eighty miles, and of material, labor, and depreciation, $1.98 per car day; the total being $3.46 per car day, or 4.32 cents per car mile. This is to be compared with the ten cents a car mile that horses cost, and in the latter estimate there is no allowance for depreciation of cars, etc. At present there is a saving in this line of $125 a day as compared with horses. The passengers carried are over 10,000 per day.

Passing to the application of electricity on a larger scale, Mr. Sprague considers the problem of the elevated roads. At present steam engines weighing 22½ tons, with a capacity of 185-horse power are used. For a proper service the number of cars should be increased at certain hours, but the weight of the locomotive will not give traction enough for the desired increase, and the strength of the structure will not allow an increase in its weight. As to the energy used, 59 per cent is employed in starting, 24 per cent in lifting, 17 per cent in traction; the average horse power is 70.3. Mr. Sprague's substitute for the locomotive is a car with an electric motor geared to each axle. In stopping and in going down grades he will brake by making his motors into dynamos, feeding current into the line for the other trains, thus recovering a part of the energy lost in starting and in going up grade. The motors are to have a collective capacity of 300-horse power, and the car will be used for passengers: at each end of it will be a compartment for the motor men.

Mr. Sprague's ideal railroad system for New York is as follows: There would be four tracks from the Battery up Broadway to Twenty-third street; thence diverging in two divisions, each still with four tracks, one along the line of Madison Avenue to the Harlem River; the other following Broadway and running up the line of the Boulevard and Tenth or Eleventh Avenue. Two tracks would be for express, two for way traffic: they would be in two tiers, the former below the latter. Electric cars are to be used, the current delivered from an overhead wire; express speed, thirty miles, way trains, twelve miles per hour. This system is to be supplemented by surface cars operated by electricity.

These are the main points in Mr. Sprague's paper, which will be discussed in the fall meeting of the Institute of Electrical Engineers.

MENTAL SCIENCE.

Experiments in Thought-Transferrence.

THE English Society for Psychical Research has definitely accepted the theory of telepathy, or a mode of communication between mind and mind other than that through the recognized channels of sensation. A portion of the evidence upon which they found that belief is of an experimental nature, and it is this portion that is most apt to arouse the attention of scientific men; it is this portion, too, that is certain to bring to light obscure phases of mental action, irrespective of the answer it may yield as to the possibility or impossibility of thought-transferrence. In the last issue of the Proceedings of the English Society (June, 1888), M. Charles Richet, well known as a physiologist, and editor of the

Revue Scientifique, contributes a full account of his varied and elaborate researches in this new field.

These experiments, coming from so eminent an experimenter, made with a sound knowledge of the sources of error inherent in such work, and presented with a pleasant modesty, are worth the consideration equally of those who do not agree with the conclusions of M. Richet[1] and of those whose views are strengthened by these new experiments. M. Richet has been pursuing this investigation for six years, and, if he has been deceived by his subjects, it can only be that the topic presents an unusually puzzling and deceptive aspect.

After an introduction dealing with the precautions to be taken, and emphasizing the fact that at bottom we must trust to the honesty of our subjects, he can do no better than ask the reader to take his word for the observed good faith of the subjects, and equally well assure the reader that he has ever been on his guard against that greatest of wonder-workers, 'unconscious self-deceptions.' Furthermore, we must require only such a degree of probability for our results as would be satisfactory in other sciences. The slightest defect invalidates the whole observation, and a well-established, not very wonderful result is to be preferred to a striking one less securely established.

His subjects are four hysterical women between the ages of twenty-one and forty-five, all subject to hypnotism, and some with a tendency to natural somnambulism, and other signs of an unstable nervous constitution. The first test consisted in willing the patient to go to sleep, M. Richet being at a house five hundred and fifty yards distant. On going to the house he puts the subject to sleep, and she tells him that for a certain twenty minutes of the morning he was trying to put her to sleep, and that she went to sleep. The time is approximately correct. The experiment is varied, and the coincidence of the time of M. Richet's willing and of the patient's sleeping varies from a remarkable exactness to quite wide approximations. However, M. Richet is convinced that the successes are more numerous than can possibly be explained as due to chance. Between coincidence and telepathy, he chooses the latter.

Very many attempts were made to transfer a simple drawing from M. Richet's mind to that of the subject. Many illustrations of the result are figured, and without such illustrations it is useless to describe the result. But the new fact that M. Richet records is that the experiment succeeded nearly or quite as well when he was ignorant of the design contained in the envelope as when he knew it. Here thought-transferrence is out of the question, and M. Richet has recourse to the theory of a sort of clairvoyance to which he gives the generic name of 'lucidity,' a vision in which the ordinary optical impediments no longer act as such. It must be added, that as a rule the subject did not draw her reproduction, but described it part by part, and it was drawn by M. Richet. Selections from the most successful sixth of the results are alone described. Moreover, the very admirable plan was adopted of experimenting with normal subjects by selecting sixty designs, and recording the good results. For seven successes in two hundred with these subjects, he can show twenty with his selected subjects, so that the normal degree of success is to some extent ascertained.

Another and very questionable form of test was to have the subject, either in a normal or hypnotic state, describe the disease of a patient thought of, or a lock of whose hair was shown. The descriptions are in vague terms, and the amount of success is by no means remarkable.

Experiments were made in which the letters of an alphabet are moved over by one person, while a group of persons sit at a table, and the letters are recorded at which the pen stopped when the table moved under the more or less unconscious impulse of the sitters. When these letters are put together, they form a more or less close resemblance to what was thought of or asked for. The fact that sentences thus emerge, if fact it is, is certainly extremely wonderful.

Experiments with cards were tried; and the success in guessing the color, the suit, and the grade, compared with the success by chance, yields the result that no evidence of 'lucidity' is present. The guessing of names was no more successful. Other observations of a miscellaneous character, and dealing with coincidence, are recorded. These give one the feeling that a great many wonderful things have been happening to M. Richet since he has become interested in this study.

M. Richet takes the position that chance or a new mode of mental action is the only way of explaining the results. This is far from self-evident. On the contrary, it is infinitely more probable that a natural mode of explanation has escaped our observation, and especially so in this unexplained region of mental phenomena. We know, as M. Richet points out, how very shrewd subjects are in anticipating results by unconscious suggestion, and the limits of this power have by no means been reached. We ought, then, to so arrange our experiments that this power finds no field for application. It is not sufficient to refrain from all conscious intimation of the expected result, but this result must not be capable of any such intimation. It is in this point that M. Richet's experiments are sadly deficient. Instead of finding when his subject went to sleep by her account of it, let a schedule be arranged that five times per day for a period of fifteen minutes he should will the distant subject to sleep; then let the hours be determined by hazard, and record the result. Everywhere we require simplicity of conditions with the amount of success due to chance precisely calculable. It is striking that the card experiments, which alone answer this condition, are entirely negative in result. Again, the drawing experiments are useless until we have a system of calculating successes. The designs are largely the combination of a few elements; and if, as M. Richet at times does, we calculate the appearance of one of these elements as a partial success, it is easy to prove telepathy. Finally (for objections could be indefinitely multiplied), the inference from the fact that success was obtained when the operator did not do the drawing, is not that we must suppose lucidity, but that this is excellent evidence against telepathy, and strongly suggests that the percipient has some method of seeing enough of the design to get three times as many as the normal number of successes. The problem is by no means a simple one, and theories of any kind are premature. In maintaining a scientific interest in such phenomena the Psychic Research Society is performing a very useful function.

THE PSYCHOLOGY OF SPIRITUALISM. — In the July number of the *American Magazine*, Dr. Allan McLane Hamilton writes to the point in reference to the delusion which has recently figured in the law courts. He shows the relationship of this to other psychic delusions, and describes the conditions under which false mental images arise, and lead to the weakening of the judgment.

[1] The present writer counts himself among this number, and, inasmuch as it is impossible to eliminate individual opinion in so new a question, will criticise the experiments from this negative point of view.

BOOK-REVIEWS.

The Constitution of the United States, with notes. EDWIN D. MEAD. Boston, Heath. 16°.

THE proprietors of the Old South Meeting House established in 1883 a series of lectures on historical and political subjects, with the special object of instructing the young. The lectures have proved popular, and are doubtless doing good; so that the hope is now entertained that they will be permanently continued, and will give rise to other courses of like character elsewhere. In connection with these lectures a series of pamphlets have been issued, called the 'Old South Manuals,' of which this copy of the National Constitution is one. It is of convenient size and well printed. The notes are historical and bibliographical, and though of necessity brief, they convey a good deal of information, and will be specially valuable as showing the student where to go for further instruction. The editor of the work, as well as the managers of the lectures, take a broad view of the subject with which they deal, and are not among those who think that American history and politics can be studied apart from those of the world in general. The vital connection of our institutions with those of England is fully apprehended by Mr. Mead, and several of his notes are devoted to this subject. The leading authorities on both English and American constitutional history are pointed out, and the student who wishes to pursue the subject thoroughly will find this little book a sufficient and trustworthy guide.